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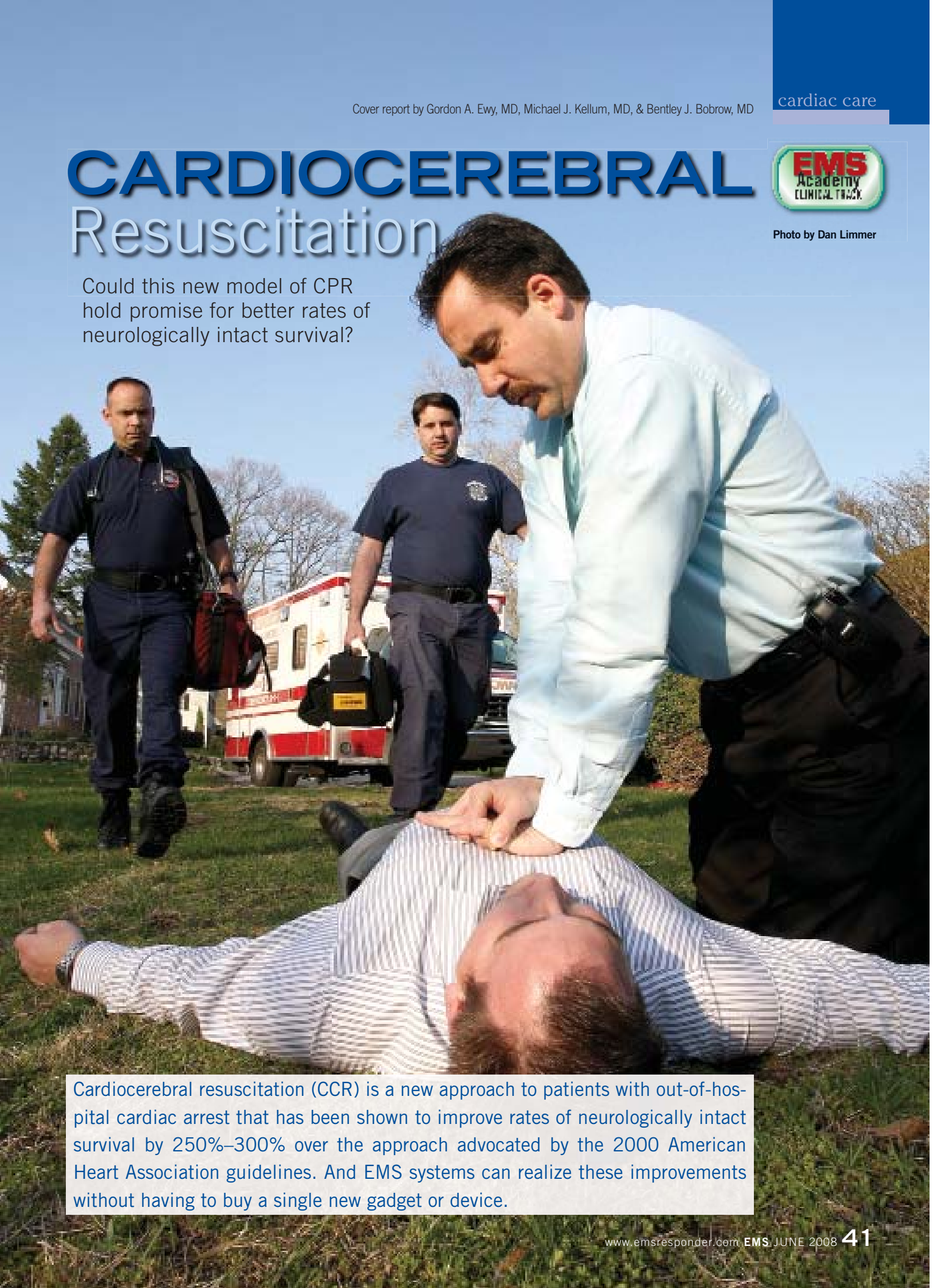
CARDIOCEREBRAL Resuscitation

EMS Academy Clinical Track

Photo by Dan Limmer

Could this new model of CPR hold promise for better rates of neurologically intact survival?



Cardiocerebral resuscitation (CCR) is a new approach to patients with out-of-hospital cardiac arrest that has been shown to improve rates of neurologically intact survival by 250%–300% over the approach advocated by the 2000 American Heart Association guidelines. And EMS systems can realize these improvements without having to buy a single new gadget or device.

CCR consists of three major components:

1) Continuous chest compressions (CCC) without mouth-to-mouth ventilation for all bystanders of witnessed cardiac arrests and for first responders.

2) A new advanced cardiac life support algorithm that delays endotracheal intubation, emphasizes minimal interruptions of chest compressions, deemphasizes positive-pressure ventilations, prioritizes defibrillation according to the three-phase time-sensitive model of ventricular fibrillation, and encourages early administration of epinephrine. Cardiocerebral resuscitation is also for basic EMTs—they,

Figure 1: The Cardiocerebral Resuscitation protocol.

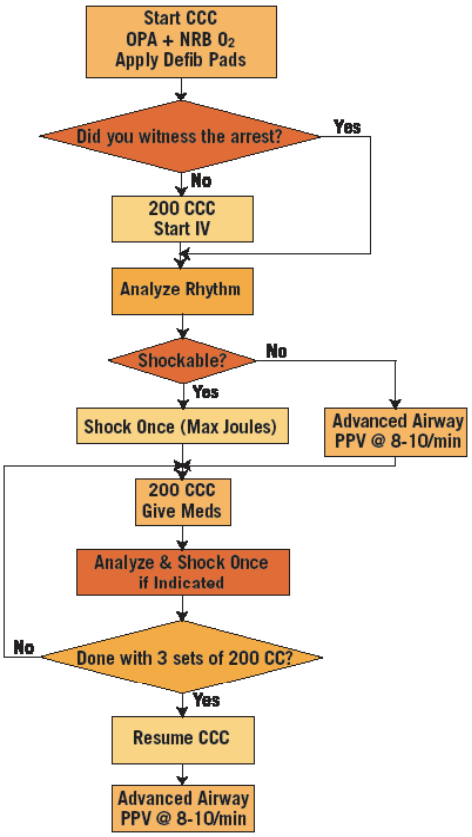


Figure Key
CCC = continuous chest compressions
OPA = oral-pharyngeal airway
NRB = nonrebreather mask
Advanced airway = endotracheal tube or Combitube
PPV = positive-pressure ventilations.

too, should deliver continuous chest compressions at a rate of 100 per minute. Invasive airway insertion is delayed, and positive-pressure ventilations are not utilized during the initial minutes of resuscitation. Epinephrine, when appropriate, is administered via IV or IO ASAP when paramedics arrive.

3) The newest component of cardiocerebral resuscitation is advocating the establishment of cardiac arrest centers that can provide optimal care that includes urgent cardiac catheterization, controlled mild therapeutic hypothermia and standardized supportive care for patients in coma after resuscitation from cardiac arrest.

Why cardiocerebral resuscitation instead of standard CPR and ACLS? It saves more lives! In the absence of early defibrillation by AEDs, survival of patients with out-of-hospital cardiac arrest (OHCA) treated per American Heart Association guidelines has, since their introduction in 1974, been poor in most of the world. It has not significantly improved in spite of updated standards and/or guidelines in 1980, 1992 and 2000, despite millions of dollars and man-hours spent in development, training and implementation.

> "The CCR protocol is reserved for cases in which an out-of-hospital arrest is presumed to be cardiac in origin."

While we are intellectually convinced that CCR is now the optimal approach to patients with out-of-hospital cardiac arrest, the greatest proponents are providers in systems that have adopted CCR. CCR was instituted in Tucson, AZ, in 2003; in Rock and Walworth Counties, WI, in 2004; in metropolitan Phoenix in 2005 and across Arizona thereafter; and in Kansas City, MO, in 2006 and Kansas City, KS, in 2007. They have viscerally experienced the improved results. In 2008, CCR was instituted in other areas of Wisconsin. Darren Bean, MD, an emergency physician in Madison, reported that, "We have had four survivors in the past 14 days, one of whom had 43 minutes of refractory VF prior to ROSC. To our collective disbelief (even the most enthusiastic supporters of CCR have difficulty believing that 43 minutes of low-flow state could result in anything other than neurologic devastation), he awoke with a completely normal neurologic outcome."

CCR FOR BYSTANDERS

We were delighted that the AHA recently advocated "hands-only" or "compression-only" CPR for bystanders of witnessed arrests. We have been advocating this approach for years. However, we do not think the AHA recommendations go far enough, as they state that trained individuals should still utilize the 30:2 compression-to-ventilation ratio if they believe they can perform the ventilations with minimal interruptions of chest compressions.

While ventilations are probably necessary in unwitnessed cardiac arrests, patients with witnessed arrests do not initially need assisted ventilation because their arterial oxygen content is sufficient for several minutes of chest compression-only CPR. In subjects who gasp, the arterial oxygen content remains adequate for up to 15 minutes with chest compressions only. Because the perfusion of the brain and heart are so marginal during resuscitation efforts, interrupting or delaying chest compressions for ventilation or other interventions, except for defibrillation, is deleterious.

If there is more than one person on scene, should one of the rescuers do assisted ventilations while the other does CCC? Surprisingly, the answer is no. With normal ventilation, breathing results in a negative pressure inside the chest that not only causes air to enter the lungs, but enhances

blood return to the heart as well. This negative intrathoracic pressure also improves cerebral blood flow. On the other hand, when one ventilates a patient with cardiac arrest, one is increasing the pressure inside the chest, decreasing blood return to the chest and decreasing blood flow to the brain.

This is in stark contrast to respiratory arrests, such as drowning, where continued normal cardiac output in the face of inadequate oxygen results in rapid depletion of arterial oxygen content, leading to hypotension and, finally, secondary cardiac arrest. Here ventilatory support is clearly needed, and until better information is available, the AHA's 30:2 ratio is recommended.

One reason the guidelines have not, until now, advocated different approaches to cardiac and respiratory arrests was the assumption that lay individuals could not tell the difference between them. It is important, in your training of the public, to emphasize that any person who collapses suddenly, is not responsive and is not breathing normally is indeed a cardiac arrest victim. Be sure to emphasize that there are two types of abnormal breathing: gasping (snoring or agonal respirations), and not breathing at all. Many subjects with witnessed arrests will continue to gasp and provide physiologic ventilation—that is, ventilation with decreased intrathoracic pressures—so that assisted positive-pressure ventilation is not necessary. Or, if allowed, they will begin gasping with CCC CPR.

CCR FOR EMS

The cardiocerebral resuscitation protocol (*Figure 1*) is reserved for cases in which an out-of-hospital arrest is presumed to be cardiac in origin—i.e., individuals with sudden, unexpected collapses with absent or abnormal breathing. In all other situations, AHA guidelines for ACLS should still be used.

EMS should give 200 uninterrupted chest compressions (100 per minute) before each rhythm analysis and single shock, if indicated, followed immediately by another 200 chest compressions and repeat rhythm analysis. Patients are not moved from the scene until three cycles of 200 compressions/rhythm analysis. In most cases they are not transported until they are resuscitated or pronounced dead.

Initial airway management is delayed until a second rescuer is available and is initially limited to placement of an oral-pharyngeal airway and administration of oxygen by non-rebreather mask. Insertion of an invasive airway and assisted ventilation are not performed until either return of spontaneous circulation or after three cycles of chest compressions, analysis and, when needed, shock. Most who have ROSC are intubated prior to transportation.

When positive-pressure ventila-

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tions are delivered, it was initially recommended that they be limited to a rate of 8–10 per minute. There is good evidence that this should be as few as six.

The technique of chest compressions is ideally performed with a metronome attached to the defibrillator to emphasize the importance of a rate of 100 per minute. Full chest recoil after each compression is essential.

If only one responder is on scene, the defibrillator or AED pads are applied before chest compressions are initiated in an effort to minimize the pause between stopping compressions and the defibrillation shock. For CCR, AEDs need to be reprogrammed, or their voice instructions ignored.

SUPPORTING LITERATURE

To date there have been three formal publications of outcomes using cardiocerebral resuscitation. The first was from Wisconsin, where survival during the first year of CCR was compared to the previous three years of CPR per the 2000 guidelines. Neurologically normal survival of witnessed arrests with shockable rhythms tripled, from 15% to 45%.[1] The second was from Arizona, including cities in the Phoenix metropolitan area; there survival of such patients more than tripled, from 5% to 18%.[2] The third was a three-year follow-up of the Rock and Walworth County results, in which survival increased from 15% to 40%, including one patient who received post-resuscitation hypothermia.[3]

Hyperventilation is a common error committed by both physicians and paramedics. In two different studies where nurses were sent to monitor the ventilation rates of physicians in-hospital and paramedics out-of-hospital, the average rate was surprisingly the same: 37 a minute! These observations and other studies prompted other researchers to emphasize the dangers of hyperventilation during cardiac arrest.[4] In an effort to limit this harmful effect (hyperventilation during cardiac arrest increases pressures in the chest, markedly reducing venous return to the right atrium and thus to the heart and brain), passive oxygen insufflation—that is, placement of an oral-pharyngeal airway, a non-rebreather mask and high-flow (10–15 lpm) oxygen—was instituted.

The major difference between the Rock/Walworth approach and the approach in Phoenix was that in the former, passive oxygen insufflation was used, whereas when EMS providers in Arizona were trained in CCR, it was recommended, but bag-valve mask ventilation (8–10 breaths/min.) was allowed. Preliminary analysis showed that survival was significantly better with passive oxygen insufflation for those with witnessed arrests and VF on EMS arrival, as noted in the CCR protocol (*Figure 1*).

Is the patient ever shocked first, as previously recommended? One of the major contributions to the field of resuscitation science was the description by Drs. Myron Weisfeldt and Lance Becker of the three-phase time-sensitive model of ventricular fibrillation.[5] The first phase of untreated VF is the electrical phase, the second is the circulatory phase, and the third is the metabolic phase. During the first five minutes, or electrical phase, of untreated VF, the most important therapy is prompt defibrillation. That is why implantable defibrillators and AEDs are effective. However, after about five minutes of untreated VF, the heart has depleted its energy stores, and defibrillation most often results in a nonperfusing rhythm—asystole or pulseless electrical activity. Thus, if EMS personnel witness a collapse, the approach is as it has always been: immediate defibrillation. If the arrest is not witnessed by EMS and adequate chest

compressions have not been administered by bystanders or other first responders, then 200 chest compressions are performed before defibrillation. However, doing 200 compressions post-defibrillation is still recommended to help re-establish arterial pressures earlier. The third, metabolic phase of untreated VF begins after about 15 minutes. Here, entirely new approaches are needed, as most subjects still untreated cannot be resuscitated. ■

We thank the hundreds of county sheriff and municipal law officers in Rock and Walworth Counties who functioned as first responders, and the paramedic/firefighters in Wisconsin and Arizona for their dedication and sacrifice daily in the line of duty.

References

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2. Bobrow BJ, Clark LL, Ewy GA, et al. Minimally interrupted cardiac resuscitation by emergency medical services providers for out-of-hospital cardiac arrest. *JAMA* 229:1,158–65, 2008.
3. Kellum MJ, Kennedy KV, Barney R, et al. Cardiocerebral resuscitation improves neurologically intact survival of patients with out-of-hospital cardiac arrest. *Ann Emerg Med* 2008, in press.
4. Aufderheide TP, Lurie KG. Death by hyperventilation: A common and life-threatening problem during cardiopulmonary resuscitation. *Crit Care Med* 32:S345–51, 2004.
5. Weisfeldt M, Becker L. Resuscitation after cardiac arrest: A 3-phase time-sensitive model. *JAMA* 288:3,035–38, 2002.

Additional References

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Additional Resources

• Video lectures by Dr. Ewy on cardiocerebral resuscitation can be accessed at the links below. Part 1 examines bystander CCC; Part 2 looks at new EMS approaches to cardiocerebral resuscitation.

Part 1:

http://video.biocom.arizona.edu:8080/asxgen/realstor/2008/03/18/CPR2008_03_18a.wmv

http://video.biocom.arizona.edu:8080/ramgen/realstor/2008/03/18/CPR2008_03_18a.rm

Part 2:

http://video.biocom.arizona.edu:8080/asxgen/realstor/2008/03/18/CPR2008_03_18b.wmv

http://video.biocom.arizona.edu:8080/ramgen/realstor/2008/03/18/CPR2008_03_18a.rm

• A complimentary presentation by Dr. Kellum is available at www.arizonaheart.org.

• More information is also available on the Save Hearts in Arizona Research and Education (SHARE program) website, www.azshare.gov.

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